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Engineering Statement
Experimental Authorization Request
Channel 17 and 32 at Madison, Wisconsin
December 2022

I. Background

This Engineering Statement has been prepared on behalf of 5Nines, LLC ("5Nines"), in support of a request for Experimental Authorization to utilize DTV Channels 17 and 32 at Madison, Wisconsin, with the technical facilities specified herein.

A separate document describes the justification for the Experimental Authorization request, and the nature of the testing to be performed. This Engineering Statement specifies the technical specifications and demonstrates that the proposed operation complies with the Commission's Rules for interference protection to cochannel and adjacent channel digital television stations, both high-power and low-power.

II. Technical Details

Channels	Channel 17 (488-494 MHz) Channel 32 (578-584 MHz) Identical technical facilities are requested, as detailed below	
Transmitter site coordinates (NAD83)	43 - 04 - 27.1 89 - 22 - 41.5	
Transmitter site elevation	259 meters AMSL	
Structure overall with antenna	54.8 meters AGL	
Radiation center	54.6 meters AGL 313.6 meters AMSL	
Structure Type	Building with pipe	
ERP	0.240 kW	
Emission Mask	Stringent	
Antenna model	KP Performance Antennas model KP-TWDPFP9 9.0 dBi gain (6.85 dBd)	
Antenna orientation	45 degrees True	
Antenna pattern data (Relative Field)	0.0,1.000 10.0,1.000 20.0,1.000 30.0,1.000 40.0,0.891 50.0,0.631 60.0,0.447 70.0,0.316 80.0,0.178 90.0,0.133 100.0,0.133 110.0,0.133 120.0,0.133 130.0,0.178 140.0,0.178 150.0,0.178 160.0,0.178 170.0,0.178	180.0,0.178 190.0,0.178 200.0,0.178 210.0,0.178 220.0,0.178 230.0,0.178 240.0,0.133 250.0,0.133 260.0,0.133 270.0,0.133 280.0,0.178 290.0,0.316 300.0,0.447 310.0,0.631 320.0,0.891 330.0,1.000 340.0,1.000 350.0,1.000
Transmitter	Advanced Digital model ADV-8300 ATSC Modulator RF-Links model ZHS-4053-60 Linear Amplifier	
Emission Designator	6M00C7W (ATSC digital TV)	

III. Interference Study

Study has been made of all cochannel and adjacent-channel facilities in the vicinity of the proposed experimental operation on both Ch17 and Ch32, including a detailed Longley-Rice interference study to demonstrate that the proposed operation will not cause interference to any authorized or pending proposed facilities. This study was performed using the Commission's TVStudy software.

The results of this study indicate that the proposed experimental operation is predicted to cause zero additional interference to any of the listed stations, beyond the allowed values of 0.5% to full-power and Class A stations, and 2.0% to low-power stations. Based on the foregoing interference study, it is believed that the proposed facility can operate without risk of interference to other stations.

TVStudy Run Results for Channel 17

Study created: 2022.11.29 14:38:19

Study build station data: LMS TV 2022-11-28

```
    Proposal: MADEX17 D17 LD APP MADISON, WI
 File number: MADEX17
 Facility ID: 99999
Station data: User record
   Record ID: 1339
     Country: U.S.
```

Build options:
Protect pre-transition records not on baseline channel

Stations potentially affected by proposal:

IX	Call	Chan	Svc	Status	City, State	File Number	Distance
No	WTVO	D16	DT	LIC	ROCKFORD, IL	BLCDT20021024AAS	89.1 km
No	W16DU-D	D16	LD	LIC	BLOOMINGTON, WI	BLANK0000062263	128.9
No	WYTU-LD	D16	LD	LIC	MILWAUKEE, WI	BLANK0000084618	117.6
No	K17MH-D	D17	LD	LIC	CEDAR FALLS, IA	BLANK0000177243	282.1
No	KWQC-TV	D17	DT	LIC	DAVENPORT, IA	BLANK0000097891	192.3
No	KDIT-CD	D17-	DC	LIC	Des Moines, IA	BLANK0000199021	373.9
No	WLCF-LD	D17	LD	LIC	DECATUR, IL	BLANK0000121247	349.7
No	W17EH-D	D17	LD	CP	QUINCY, IL	BLANK0000185140	381.0
No	WEIJ-LD	D17	LD	LIC	FORT WAYNE, IN	BLANK0000177440	408.9
No	WYIN	D17	DT	LIC	GARY, IN	BLEDT20040206AAA	251.5
No	WPBI-LD	D17	LD	LIC	LAFAYETTE, IN	BLANK0000088160	363.5
No	WOTV	D17	DT	LIC	BATTLE CREEK, MI	BLANK0000141782	323.5
No	WMNN-LD	D17	LD	LIC	LAKE CITY, MI	BLANK0000118076	351.4
No	K17MX-D	D17	LD	LIC	FROST, MN	BLANK0000062750	372.3
No	KMWE-LD	D17	LD	APP	SAINT CLOUD, MN	BLANK0000203353	362.4
No	NEW	D17	LD	CP	SIOUX FALLS, SD	BNPDTL20090825AWE	64.9
No	NEW	D17	LD	APP	SIOUX FALLS, SD	BLANK0000201121	29.4
No	WEAU	D17	DT	LIC	EAU CLAIRE, WI	BLANK0000120880	217.5
No	WGBD-LD	D17	LD	LIC	GREEN BAY, WI	BLANK0000068358	185.5
No	WBME-CD	D17	DC	LIC	MILWAUKEE, WI	BLANK0000086894	117.6
No	W17DZ-D	D17	LD	LIC	SISTER BAY, WI	BLANK0000086983	301.8
No	KYIN	D18	DT	LIC	MASON CITY, IA	BLEDT20090612AHJ	273.1
No	KRIN	D18	LD	APP	WATERLOO, IA	BDRTEDT20120604AFO	118.6
No	WMEU-CD	D18	DC	LIC	CHICAGO, IL	BLANK0000086889	195.0
No	WMEU-CD	D18	DC	CP	CHICAGO, IL	BLANK0000196962	194.3
No	DWMKB-LP	D18z	LD	APP	Rochelle, IL	BLANK0000054707	120.7
No	WLUK-TV	D18	DT	LIC	GREEN BAY, WI	BLANK0000199689	185.5
No	WMSN-TV	D18	DT	LIC	MADISON, WI	BLANK0000113879	12.9

No non-directional AM stations found within 0.8 km

No directional AM stations found within 3.2 km

Record parameters as studied:

```
    Channel: D17
       Mask: Stringent
   Latitude:  43  4 27.10 N (NAD83)
  Longitude:  89 22 41.50 W
Height AMSL: 313.6 m
       HAAT: 0.0 m
   Peak ERP: 0.240 kW
    Antenna: KP-TWDPFP9 45.0 deg
Elev Pattrn: Generic
```

49.0 dBu contour:

Azimuth	ERP	HAAT	Distance
0.0 deg	0.139 kW	41.6 m	13.3 km
45.0	0.240	34.6	13.9
90.0	0.139	42.2	13.4

```
135.0      0.004       53.2      6.5
180.0      0.008       32.0      5.8
225.0      0.008       14.3      5.7
270.0      0.008       10.3      5.7
315.0      0.004       38.2      5.4

Database HAAT does not agree with computed HAAT
Database HAAT: 0 m   Computed HAAT: 33 m

Distance to Canadian border: 519.2 km

Distance to Mexican border: 1824.1 km

Conditions at FCC monitoring station: Allegan MI
Bearing: 99.4 degrees   Distance: 283.7 km

Proposal is not within the West Virginia quiet zone area

Conditions at Table Mountain receiving zone:
Bearing: 261.5 degrees   Distance: 1354.1 km

No land mobile station failures found

Proposal is not within the Offshore Radio Service protected area


Study cell size: 1.00 km
Profile point spacing: 1.00 km

Maximum new IX to full-service and Class A: 0.50%
Maximum new IX to LPTV: 2.00%


---- Below is IX received by proposal MADEX17 ----

Proposal receives 7.22% interference from scenario 1
No IX check failures found.
```

TVStudy Run Results for Channel 32

Study created: 2022.11.29 14:38:41

Study build station data: LMS TV 2022-11-28

```
    Proposal: MADEX32 D32 LD APP MADISON, WI
 File number: MADEX32
 Facility ID: 99999
Station data: User record
   Record ID: 1340
     Country: U.S.
```

Build options:
Protect pre-transition records not on baseline channel

Stations potentially affected by proposal:

IX	Call	Chan	Svc	Status	City, State	File Number	Distance
No	DWMKB-LP	N25z	TX	APP	Rochelle, IL	BLTTL20070813AFM	120.7 km
No	K31NJ-D	D31	LD	LIC	LANSING, IA	BLANK0000093973	152.4
No	WFLD	D31	DT	LIC	CHICAGO, IL	BLANK0000055195	195.0
No	W31EZ-D	D31	LD	LIC	CHICAGO, IL	BLANK0000124951	194.3
No	WESV-LD	D31	LD	LIC	CHICAGO, IL	BLANK0000125079	194.3
No	WQAD-TV	D31	DT	LIC	MOLINE, IL	BLANK0000120809	212.5
No	WITI	D31	DT	LIC	MILWAUKEE, WI	BLANK0000086971	120.2
No	W31EV-D	D31	LD	LIC	WAUSAU, WI	BLANK0000187442	179.3
No	W31EV-D	D31	LD	APP	WAUSAU, WI	BLANK0000193285	170.2
No	NEW	D31	DT	CP	WITTENBERG, WI	BLANK0000195584	195.8
No	KFKZ-LD	D32	LD	LIC	CEDAR FALLS, IA	BLANK0000069608	222.4
No	KCRG-TV	D32	DT	CP	CEDAR RAPIDS, IA	BLANK0000150618	219.4
No	DDKQCT-LP	D32-	LD	APP	DAVENPORT, IA	BLANK0000068394	212.5
No	K32NM-D	D32	LD	LIC	DES MOINES, IA	BLANK0000080995	392.2
No	WICD	D32	DT	LIC	CHAMPAIGN, IL	BLANK0000059351	355.5
No	WICD	D32	DT	LIC	CHAMPAIGN, IL	BLANK0000203638	355.5
No	WLPD-CD	D32	DC	LIC	PLANO, IL	BLANK0000197423	194.3
No	WTJR	D32	DT	LIC	QUINCY, IL	BLCDT20091110ADL	381.0
No	WANE-TV	D32	DT	LIC	FORT WAYNE, IN	BLANK0000121250	410.3
No	WFQX-TV	D32	DT	LIC	CADILLAC, MI	BLCDT20091217ACU	345.6
No	WFQX-TV	D32	DT	CP	CADILLAC, MI	BLANK0000035809	345.6
No	WJMN-TV	D32	DT	LIC	ESCANABA, MI	BLANK0000063727	390.7
No	WXMI	D32	LD	LIC	GRAND RAPIDS, MI	BLANK0000072959	315.7
No	W32CV-D	D32+	LD	LIC	IRONWOOD, MI	BLANK0000016623	379.7
No	W32CV-D	N32+	TX	LIC	IRONWOOD, MI	BLTT20040217ACE	379.7
No	WCCO-TV	D32	DT	LIC	MINNEAPOLIS, MN	BLANK0000176702	372.9
Yes	WTMJ-TV	D32	DT	LIC	MILWAUKEE, WI	BLANK0000086939	119.9
No	K18NQ-D	N32-	TX	LIC	RHINELANDER, WI	BLTT20050929AGL	300.4
No	K20KF-D	D33	LD	CP	DAVENPORT, IA	BLANK0000198325	197.5
No	WMAQ-TV	D33	DT	CP	CHICAGO, IL	BLANK0000080396	195.0
No	WLAX	D33	DT	LIC	LA CROSSE, WI	BLANK0000121622	180.2
No	WZAW-LD	D33	LD	LIC	WAUSAU, WI	BLANK0000013771	220.4

No non-directional AM stations found within 0.8 km

No directional AM stations found within 3.2 km

Record parameters as studied:

```
    Channel: D32
       Mask: Stringent
   Latitude:  43  4 27.10 N (NAD83)
  Longitude:  89 22 41.50 W
Height AMSL: 313.6 m
       HAAT: 0.0 m
   Peak ERP: 0.240 kW
    Antenna: KP-TWDPFP9 45.0 deg
Elev Pattrn: Generic
```

50.5 dBu contour:

Azimuth	ERP	HAAT	Distance
0.0 deg	0.139 kW	41.6 m	12.2 km
45.0	0.240	34.6	12.7
90.0	0.139	42.2	12.3
135.0	0.004	53.2	6.0
180.0	0.008	32.0	5.3
225.0	0.008	14.3	5.2
270.0	0.008	10.3	5.2
315.0	0.004	38.2	5.0

Database HAAT does not agree with computed HAAT
Database HAAT: 0 m Computed HAAT: 33 m

Distance to Canadian border: 519.2 km

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Conditions at FCC monitoring station: Allegan MI
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Proposal is not within the West Virginia quiet zone area

Conditions at Table Mountain receiving zone:
Bearing: 261.5 degrees Distance: 1354.1 km

Study cell size: 1.00 km
Profile point spacing: 1.00 km

Maximum new IX to full-service and Class A: 0.50%
Maximum new IX to LPTV: 2.00%

No IX check failures found.

IV. RF Exposure Study

The power density calculations shown below were made using the techniques outlined in OET Bulletin No. 65. "Ground level" calculations in this report have been made at a reference height of 2 meters above ground to provide a worst-case estimate of exposure for persons standing on the ground in the vicinity of the tower. The equation shown below was used to calculate the ground level power density figures from each antenna.

$$S(\mu W / cm^2) = \frac{33.41 \times AdjERP(Watts)}{D^2}$$

Where: *AdjERP(Watts)* is the maximum lobe effective radiated power times the element pattern factor times the array pattern factor.

D is the distance in meters from the center of radiation to the calculation point.

Power density levels produced by the proposed experimental facility were calculated for an elevation of 2 meters above ground (52.6 meters above ground level) assuming that the antenna will radiate 100% power straight down (240 watts H + 240 watts V). Under this worst-case assumption, the highest calculated ground-level power density from the proposed antenna alone occurs at a point 0 meters from the base of the antenna support structure. At this point the power density from the proposed facility is calculated to be 5.8 μW/cm², which is 1.8% of 325.3 μW/cm² (the FCC MPE for uncontrolled environments at the Channel 17 frequency) and 1.5% of 385.3 μW/cm² (the FCC MPE for uncontrolled environments at the Channel 32 frequency)

The transmitting antenna will be installed on a railing which extends four feet above the building rooftop. The antenna main lobe will be pointed away from the building, and based on the manufacturer's azimuth pattern we have assumed pattern suppression of -15 dB (0.178 relative field) at azimuths which are 90 degrees or more off-axis from the main lobe. Thus the worst case power behind the antenna (i.e. towards the rooftop) will be 15.2 watts.

(240 watts H + 240 watts V) x 0.178^2 = 15.2 watts

Using this power level and solving for *D* at the worst case frequency (Channel 17), we find that the required standoff distance from the backside of the antenna, for compliance with the FCC MPE for

uncontrolled environments, is 1.2 meters. 5Nines will ensure that the area behind the antenna is blocked off to a distance of at least 2 meters from the antenna, and will post appropriate RF warning signs, during times when the experimental facility is actively in operation.

Pursuant to OET Bulletin No. 65, all station personnel and contractors are required to follow appropriate safety procedures before any work is commenced on the antenna tower, including reduction in power or discontinuance of operation before any maintenance work is undertaken. The permittee/licensee in coordination with other users of the site must reduce power or cease operation as necessary to protect persons having access to the site, tower or antenna from radiofrequency exposure in excess of FCC guidelines.

December 1, 2022

Erik C. Swanson, P.E.